BIM-based Fine Cost Management of the Whole Process

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Abstract. This paper applies the fine management to analyze the specific work and existing obstacles in each stage of project cost management, then proposes that BIM could be technical support for fine management and solve the existing obstacles. On this basis, this paper expounds the concept and characteristics of BIM and demonstrates that the implementation of fine management in the whole process of cost management must be supported by BIM. Finally, based on the characteristics of BIM technology, the application framework of BIM in the whole process cost management process is proposed and the specific application of BIM technology in the whole process cost management is analyzed, which provides ideas and methods for fine management using in construction engineering cost management.

1. Introduction

Since the reform and opening up, the construction engineering industry has maintained a relatively high growth rate as one of the pillar industries of China's national economy. However, since 2010, the development trend of the construction industry has gradually slowed down. One of the reasons is overcapacity, and the second is the backward production management method compared with other industries.

The emergence of the fine management has made it possible to solve the problems of material waste and the emergence of a large number of engineering changes in the development of China's construction engineering industry. In the 1950s, Toyota Motor Corporation applied the concept of fine management for the first time in the production process and solved the crisis of survival, which eventually made it the top manufacturer around the world[1]. Marhani et al proposed that lean construction can increase the productivity of the project. Lean construction can help the industry to get rid of the traditional construction methods by implementing fine management in the construction management process, such as the design process and material management process, which will help stakeholders to move towards a more collaborative, sustainable and greener future[2]. Many domestic scholars have also studied the application of fine management in the actual project cost management. Liu Jie proposed the preliminary method of fine management of engineering projects by applying the value engineering in the project selection and applying the analytic hierarchy process to the bid evaluation of the project, and verified the effectiveness of the method through the case[3]. Fang Fang et al applies BIM technology to a real estate development project, indicating that BIM technology can accurately and timely deliver orders to achieve fine management of real estate development projects[4].

It can be seen from the above that there is less literature on the application of BIM technology to support the application of fine management. Therefore, this paper focuses on the application of BIM technology to solve the application of fine management in the process of engineering cost management. This paper discusses the application of the fine management in the practical project and its existing

problems. Then, the application framework of the whole process cost fine management is established with the support of BIM technology. Based on the above research, the detailed application of the fine management of the cost in the whole process of the whole process is given according to the application framework.

2. Cost Fine management in construction project

In 1992, a Finnish professor put forward the idea of applying "lean thinking" to the construction industry. He pointed out that the construction process is also a production process, but a special production process. The methods and theories used in manufacturing should be equally applicable to the construction process[5]. The fine management of project cost is not only the refinement of a certain stage in the construction process, but the fine management throughout the project. Figure 1 is a whole process cost management framework for the introduction of fine management for the current status of project cost management.

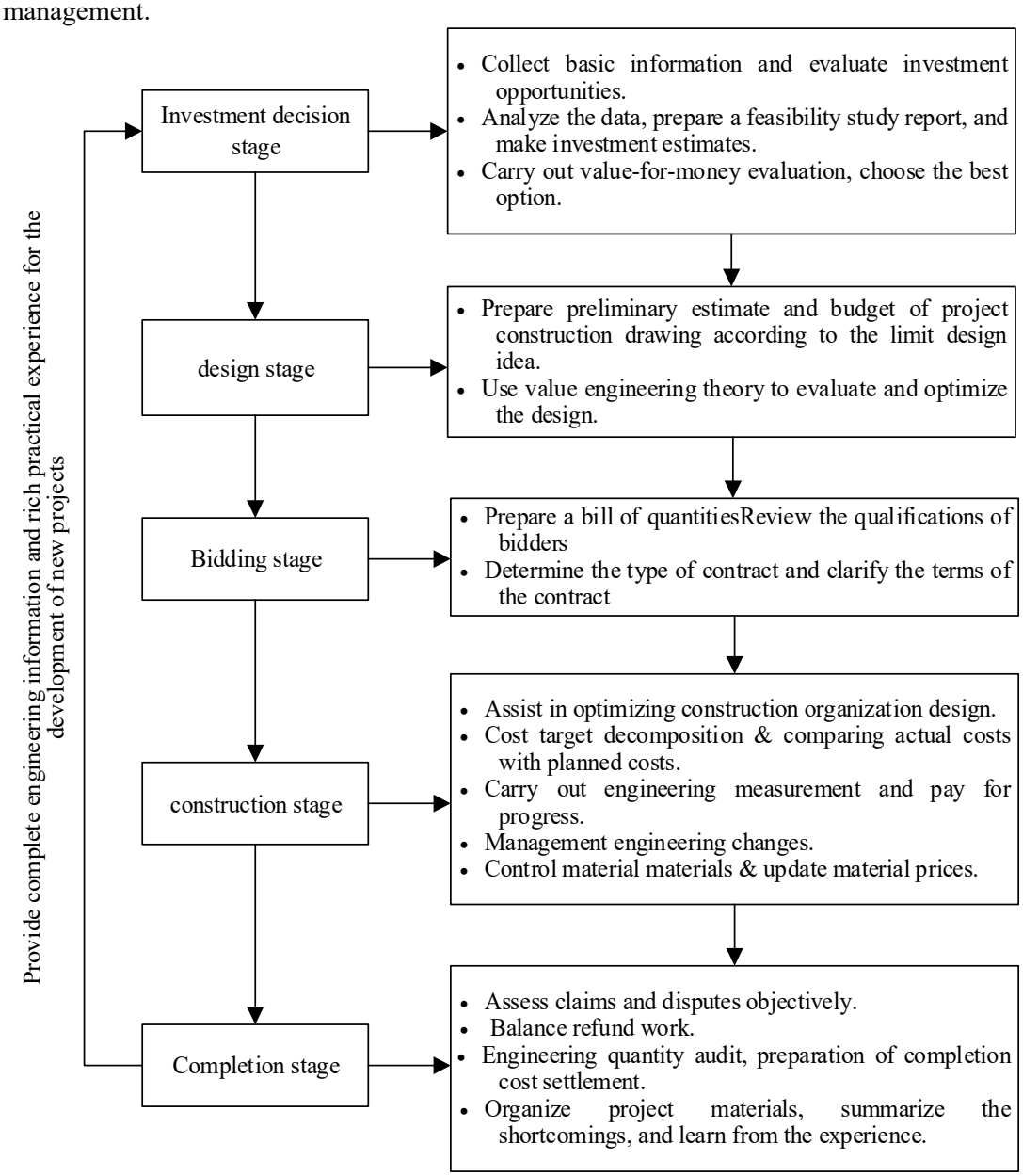

Figure 1. The application framework of fine management in the whole process of cost management.

The above analysis of the specific application of the fine management thought in each stage of the whole process cost management process, but in the actual process due to the long-term construction project, the complexity of the participants, the amount of information in the construction process and the complexity of the construction site, fine management are not well implemented. There are still many obstacles, summarized on the basis of literature analysis as shown in Table 1.

Table 1. Analysis of Application Problems of Fine Management in Cost Management Process.

classification	Description
Low Pre-project cost accuracy	Lack of professional information collection personnel. Without the specific 3D model of the project, the investment estimate cannot meet the accuracy requirements.
Low information processing speed	At present, China uses the list pricing model to calculate the price, and there are many list items. The preparation process is prone to the problem of missing items; it is difficult to achieve precise control of costs because the construction site is complicated.
Information sharing difficulties	There are many participants in the project, and the storage methods of engineering information are not the same. There is no unified platform to support the sharing of data, and the decision-making is prone to misjudgment, resulting in a lot of changes.
Information transfer distortion	The complexity and long-term nature of the project make the disconnection and distortion of the information from the previous stage to the next stage.
Old information retention method	The engineering information of completed projects is basically archived by paper documents. There is no direct logical relationship between the data, so it is difficult to get valuable cost indicators for the proposed project[6].

3. BIM-based cost fine management

From the above analysis, we can see that the information problem is the most important reason for the obstacles encountered in the practical application process. As a hot topic in the construction industry, BIM has always been mentioned in recent years. BIM technology not only saves the information of each stage of the project on the computer by establishing a parametric model, but also establishes a platform for collaborative work between the project participants. More importantly, BIM provides strong technical support for the implementation of fine management ideas in the process of project cost management.

The BIM statement at the forefront of the US national BIM standard is as follows: BIM represents a new concept that will improve waste in the construction industry and increase production efficiency. BIM refers to a product-a structured data set describing a building, an activity-the behavioral process of building a model, and a system-business system for improving work and communication efficiency, BIM is the key to reducing industrial waste, improving product value and reducing environmental damage[7]. As the revolutionary technology in the construction industry, the main application features of BIM are seen in table 2.

Table 2. The description of main features of BIM.

Characteristics	Description
Visualization	All work is based on a visual model that facilitates communication and decision making.
Coordination	BIM can check the professional models through software before the construction and the collision check between the majors. It can also be used as a unified information platform for the participants to communicate with each other during the progress of the project.
Simulatability	Refers to the simulation of the construction process or a function inside the building. It includes 3D space simulation, 4D space plus construction schedule

	simulation and 5D space plus schedule plus cost simulation.
Optimization	The BIM model integrates a large amount of information of engineering projects. Through the information analysis and simulation construction functions of computer software, the optimized design of all aspects of the building can be completed.
Graphicality	In the design stage, after colliding, coordinating and optimizing the design schemes, the owner will be provided with the comprehensive pipeline map, the collision inspection reconnaissance report and the improvement scheme [8].

3.1 BIM-based cost fine management framework for the whole process

It can be seen from the application characteristics of BIM that BIM is used as a visual information model to visually display engineering entities and as a database containing a large amount of rich engineering information, so that project participants can obtain engineering information according to their own authority at each stage of the project. At the same time, BIM is an open and transparent information exchange platform for participants to communicate and collaborate. In this paper, based on the application framework of fine management in engineering cost management, BIM-based whole process cost management framework is proposed by embedding the features of BIM, as shown in Figure 2.

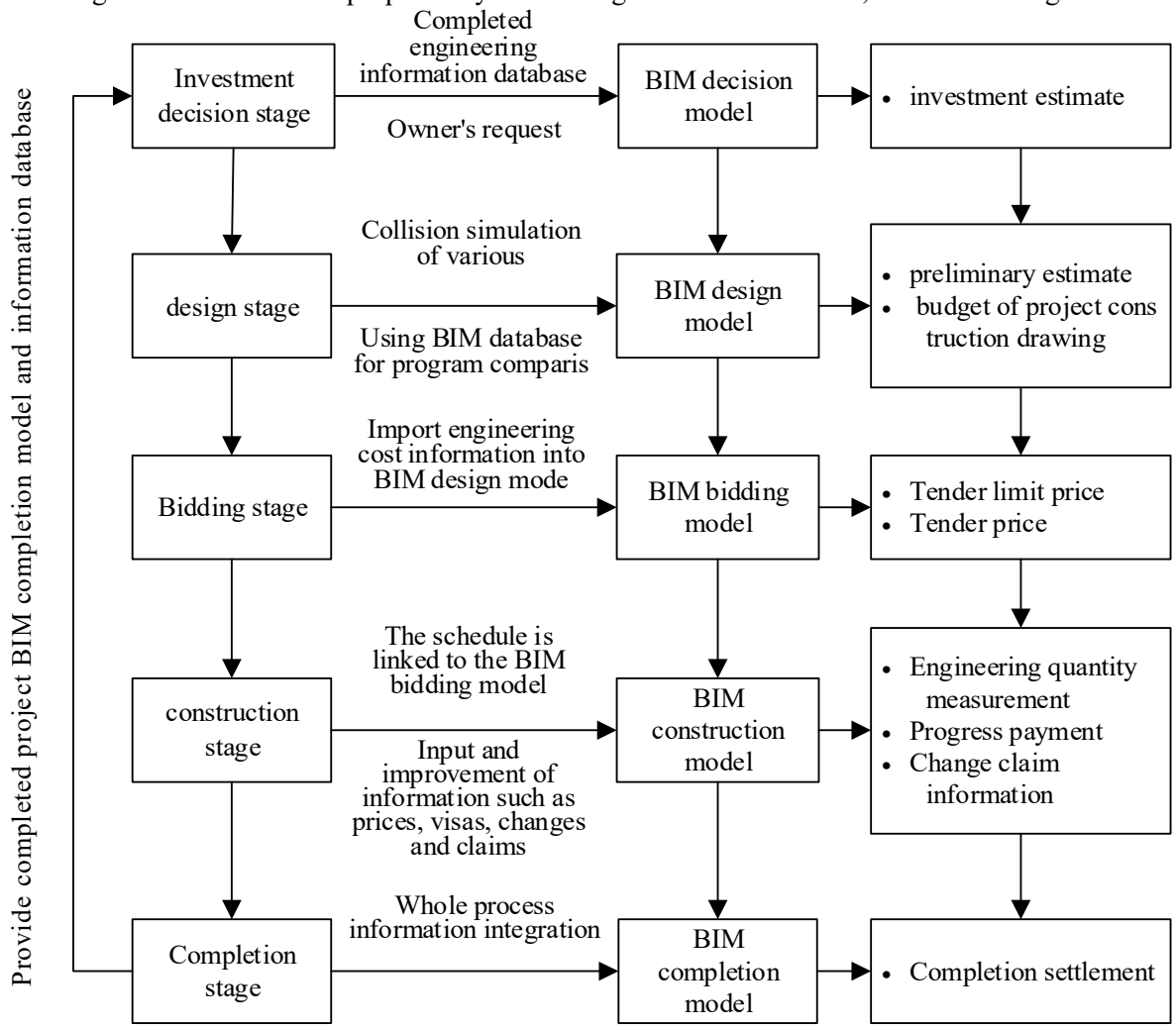

Figure 2. The application framework of BIM-based whole process cost fine management.

3.2 Application of BIM in the whole process cost fine management

According to the application framework of BIM in the whole process of cost management, it can be inferred that in all stages of the whole process cost management, the building information model established by each participant based on BIM software is the core content. With the development of the construction project, the accuracy of the BIM model is gradually improved with the continuous replenishment of information, and the cost engineers also make corresponding decisions and specific work accordingly. For the accuracy of the model, the American Institute of Architects (AIA) proposed LOD in 2008, which means the degree of detail of the model or the degree of development of the model, and is divided into five different types. The grades are LOD100, LOD200, LOD300, LOD400 and LOD500. The higher the number, the finer the development of the BIM model[9]. BIM models with different developmental precisions play different roles in all phases of the project.

3.2.1 The specific application of BIM in the investment decision stage. In the investment decision-making stage, the BIM model has a low degree of development and is defined as LOD100, which is equivalent to the result of conceptual design. The model established at this stage contains information such as roads, terrain, basic construction of buildings, spatial division, etc. Based on this information, the cost engineer can estimate the project cost and provide the basis for the preparation of the investment estimate, and directly extract and count the engineering quantities of each component, which greatly saves time for cost engineer to re-model and the accuracy of the investment estimate.

Then BIM model-based database can extract, modify, and update similar historical projects, quickly form models of different programs, and help project investors to compare and select programs intuitively and conveniently.

3.2.2 Specific application of BIM in the design stage. The BIM model in the design phase is developed based on the decision-making phase. The design phase can be divided into preliminary design and construction drawing design. The corresponding precision is LOD200 and LOD300.

In the preliminary design phase of accuracy LOD200, the information contained in the BIM model is the size and material of the structural columns, beams, slabs and other structural system components; the spatial configuration of the building, the stairs, the exterior walls of the building, the partition walls, Building components such as door and window openings and roofs, as well as the materials, properties of use, or other relevant properties of each component. On this basis, the cost engineer can quickly and accurately extract the engineering quantity and prepare the design budget.

When the preliminary design transitions to the construction drawing design, the accuracy of the model becomes LOD300 with the gradual addition of engineering information. At this time, the information contained in the model includes the form and specification attributes of the detailed components of the building, air conditioning, and water and electricity pipeline equipment. On this basis, the BIM technology can pour each sub-professional model into the relevant software and perform Collision detection so that the cost engineers can find design errors.

3.2.3 Specific application of BIM in the bidding stage. The bidding stage is the process of selecting the contractor by the owner. The main change of the model at this stage is to introduce the cost information when the bidding price or bidding price is prepared by both parties. The accuracy is not measured, and only some explanations are given for the specific application.

The emergence of BIM technology enables the parametric model that has all the information of the project in the design stage to directly and accurately extract and count the engineering quantity, and provides the cost engineer with a large amount of time to determine the price of the engineering material through the pricing software and market factors. At the same time, when the owner conducts the project bidding, the BIM model of the proposed project can be directly distributed to the bidders in the form of bidding documents, so that the bidders have more time to focus on the preparation of the construction plan. At the bidding site, the bidders can also simulate the construction plan based on the visualization

and virtual roaming function of the BIM model, and visually display the construction techniques and methods of the complex engineering parts to the owner.

3.2.4 Specific application of BIM in the construction stage. According to Chinese practice, the model development level of LOD 400 provides guidance for the construction process during the construction phase. The components in the LOD 400 model have precise quantity, shape, orientation, position, size, material, properties and have detailed construction practices, as well as analysis of component construction conflicts and energy usage analysis.

The key to cost management in the construction phase lies in the optimization of construction schemes, engineering measurement and project progress payment, material management, and engineering change management. Firstly, the cost engineer can split the original BIM model according to the time period, construction work area in performing engineering measurement on the target part, and form the engineering measurement report based on the information model under this precision. If the cost engineer picks up the relevant price information, the project progress payment can be completed. The second is to realize the management of the quantity and price of materials. The emergence of BIM technology enables the quota material to be truly applied. Through the simulation construction of the 4D construction model associated with the construction schedule and combining a large number of completed similar engineering information, BIM can accurately calculate the material requirements for each project part in a certain period of time, and truly realize the limit material picking.

3.2.5 Specific application of BIM in the completion stage. LOD 500 is the model of the completion stage. The building information model is basically consistent with the completed building entity. The components in the LOD 500 model have actual quantity, shape, orientation, position, size and have complete spatial information, change records and the cost of all installations.

Based on the information contained in this model, the cost management in the completion stage reduces the workload of the cost engineer to collect the construction process information and the engineering change data, so that the auditing efficiency of the engineering quantity is greatly improved. The BIM model is established from the investment decision stage. In the design phase and the construction phase, various aspects such as schedule, cost, resource use plan, visa change are continuously supplemented and improved. By the completion stage, the BIM model is basically in sync with the final form of the building. When both parties perform the engineering quantity review, they can pour their respective BIM models into the BIM measurement software, which promotes a significant increase in the engineering quantity verification speed.

On the other hand, the auditing efficiency of the project settlement fee is improved, and the BIM model in the completion stage covers almost all the information of the project. Therefore, when the project cost is settled, the final project settlement amount can be determined by calling the completed project quantity in the BIM database and price change information such as people, materials, and machines, engineering change information, and progress payment information.

4. Conclusion

China is in the transition period from the traditional cost management mode to the whole process cost management mode at present. There are a large number of problems that hinder the application of the whole process cost management mode. This paper puts forward the fine management of engineering cost, and aims to realize the fine management of the whole process cost, introduces BIM technology as the support, and proposes a BIM-based detailed process cost management framework. BIM integrates the construction by establishing a parametric model. The data information of all aspects of the process provides powerful technical support for the detailed management of the whole process.

According to the BIM technology visualization, coordination, simulation, optimization and other advantages and BIM precision model in different stages, not only can the information be processed efficiently, the information can be completely transmitted and saved, but also the information sharing

among the participants in each department. Work together for decision-making to make better decisions, minimize engineering changes, and achieve effective control of engineering costs.

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